CLAIMS

1. A method for introducing a physiologically active substance into a cell, which comprises: allowing a physiologically active substance to attach around a needle having a diameter of 500 nm or less, provided that it is able to be inserted into a cell; and inserting said needle into the cell.

2. The method of claim 1 wherein a needle having a diameter between 50 and 100 nm, provided that it is able to be inserted into a cell, is used.

3. The method of claim 1 or 2 wherein a needle having a length of 5 μm or less is used.

4. The method of any of claims 1 to 3 wherein a needle having a taper form, provided that it is able to be inserted into a cell, is used.

5. The method of any of claims 1 to 4 wherein a needle composed of a carbon nanotube is used.

6. The method of any of claims 1 to 4 wherein a needle composed of silicon is used.

7. The method of any of claims 1 to 4 wherein a needle composed of a metal oxide is used.

8. The method of any of claims 1 to 7 wherein the needle having a diameter between 50 and 500 nm, provided that it is able to be inserted into a cell, has electrical conductivity.

9. The method of any of claims 1 to 8 wherein the physiologically active substance is DNA, RNA, or a protein.

10. The method of any of claims 1 to 9 wherein, using a needle charged with an electrical charge opposite to that of a physiologically active substance, the physiologically active substance is allowed to electrostatically attach to said needle, and said needle is then inserted into a cell.

11. The method of any of claims 1 to 9 wherein, using a needle to which a voltage opposite to the charge of a physiologically active substance has been applied, the physiologically active substance is allowed to electrically attach to said needle, and said needle is then inserted into a cell.

12. The method of claim 10 or 11 wherein after a negatively charged physiologically active substance has been allowed to electrostatically attach to a needle that is positively charged, said needle is inserted into a cell, and the needle is then negatively charged, so that the physiologically active substance is allowed to detach from the needle.

13. The method of claim 10 or 11 wherein after a negatively charged physiologically active substance has been allowed to electrostatically attach to a needle to which a positive voltage has been applied, said needle is inserted into a cell, and a negative voltage is then applied to the needle, so that the physiologically active substance is allowed to detach from the needle.

14. The method of any of claims 10 to 13 wherein negative voltages that change over time are applied to the needle, so that the physiologically active substance is allowed to detach from the needle.

15. The method of claim 14 wherein the voltages that change over time are multiple pulse voltages.

16. The method of claim 11 or 13 wherein the needle to which a voltage opposite to the charge of a physiologically active substance is applied, is controlled in terms of voltage value and the time required for application of the voltage.

17. The method of any of claims 1 to 16 which comprises the following steps :

(1) a step of positively charging a needle;

(2) a step of immersing the needle in a solution comprising a negatively charged physiologically active substance, so that the physiologically active substance is allowed to attach around the needle;

(3) a step of inserting the needle into a target site in a cell, and then applying a negative voltage to the needle, so that the physiologically active substance is allowed to detach from the needle;

(4) a step of removing the needle from the cell; and

(5) a step of repeating the above-described steps (1) to (4), so as to introduce at least one desired, identical or different, physiologically active substance into each of multiple cells.

18. A microinjection device, which comprises: a needle having a diameter between 50 and 500 nm, provided that it is able to be inserted into a cell; a driving means for controlling the movement of said needle that enables insertion of said needle into the cell and the removal therefrom; and a voltage-applying means for applying a voltage to maintain a physiologically active substance on the surface of said needle or to remove it from said surface, wherein said needle is inserted into a cell and that the physiologically active substance is then introduced into the cell.

19. A microinjection device used for the method of any of claims 1 to 17, which comprises: a needle having a diameter between 50 and 500 nm, provided that it is able to be inserted into a cell; a driving means for controlling the movement of said needle that enables insertion of said needle into the cell and the removal therefrom; and a voltage-applying means for applying a voltage to maintain a physiologically active substance on the surface of said needle or to remove it from said surface, wherein said needle is inserted into a cell and that the physiologically active substance is then introduced into the cell.

20. The microinjection device of claim 18 or 19 which comprises a cell-retaining means for retaining a cell at a certain site and a microscope for observing the cell that is retained in the cell-retaining means.

21. The microinjection device of any of claims 18 to 20 which comprises a vessel for receiving the physiologically active substance.

22. The microinjection device of claim 20 wherein the microscope for observing the cell is provided with a means for maintaining culture environment.

23. The microinjection device of claim 18 or 19 wherein the driving means for controlling the movement of the needle, which is connected to said needle, is a piezoelectric element.

24. The microinjection device of claim 18 or 19 wherein, by the driving means for controlling the movement of the needle, said needle is inserted into a cell from the direction of gravitational force.

25. The microinjection device of claim 18 or 19 wherein, by the driving means for controlling the movement of the needle, said needle is descended to a certain height with respect to the surface of the cell-retaining means.

26. The microinjection device of claim 18 or 19 which comprises a washing tank for eliminating the physiologically active substance attached to the surface of the said needle.

27. The microinjection device of claim 26 wherein said washing tank is used to perform at least one selected from sterilized water washing, alkali washing, and acid washing.

28. The microinjection device of claim 18 or 19 wherein the time required for application of a voltage to said needle is shorter than the time at which said needle stays in a cell.

29. The microinjection device of claim 18 or 19 wherein said cell is contained in a culture solution, in which physiologically active substances are dispersed.

30. A microinjection device, which comprises: a culture solution, in which physiologically active substances are dispersed; a cell-retaining means for retaining a cell at a certain site; a needle having a diameter between 50 and 500 nm, provided that it is able to be inserted into the cell; a driving means for controlling the movement of said needle, which is connected to the needle; and a microscope for observing the cell

retained in the cell-retaining means; wherein said needle forms a hole that constitutes a pathway for introducing the physiologically active substance into the cell.

31. A method for introducing a physiologically active substance into a cell, which comprises performing microinjection using the microinjection device of any of claims 18 to 30.